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Chapter 21 Summary

Chapter 21: Magnetism and Electricity

I. Magnetism: Natural and Artificial

A. Only iron, steel, cobalt, nickel and a few rare Earth elements can be made into magnets.

1. These materials are ferromagnetic. This means that the materials are able to create spontaneous magnetism even in the absence of a magnetic field.

2. At high temperatures, ferromagnetic materials will lose their magnetism.

3. Ferromagnetic materials can be used to create artificial magnets. Alnico magnets are lightweight, strong magnets made from aluminum, nickel and cobalt.

4. Magnets are named for their shapes. Examples are bar magnets, rod magnets and U-shaped or horseshoe magnets.

B. Temporary and Permanent Magnets can be created.

1. Two types of ferromagnetic materials- Those with High Magnetic Retention and those with

Low Magnetic Retention.

2. High retention magnets are called Hard or Permanent Magnets.

3. Low retention magnets are called Soft Magnets. Ex. iron-silicon alloys.

4. Placing magnetic material in a magnetic field will create a Temporary Magnet.

5. A temporary magnet can also be created by aligning the domains in ferromagnetic material. To do this, rub (in one direction only) a piece of ferromagnetic material against a magnet.

6. An electromagnet can be created by wrapping a nail or some other ferromagnetic material

With a copper wire and apply and electrical charge.

C. Permanent Magnets are most often made from steel and iron-carbon alloys.

1. These materials are difficult to magnetize. However, they will be stronger and last longer

soft magnets.

D. Magnets can lose their magnetism by being struck, dropped and heated or by storing the same poles near one another.

E. Magnets can be kept strong if handled and stored properly.

1. Put a keeper across a U- shaped magnet

2. Store bar magnets together, only letting opposite poles touch

3. Disc or ring magnets should be stored in pairs with opposite poles touching.

F. Weak magnets can be rejuvenates.

1. Bar magnets can be restored by dragging them lengthwise across one pole of a strong

magnet.

2. Magnets can be tested with compasses, be suspending a magnet from a string and letting the

poles settle and by bringing like poles together.

3. If poles are opposite to marking after rejuvenation, the process can be performed again in

correct manner.

` 4. A bar magnet can be rejuvenated by applying an electrical current.

II. The Law of Magnetic Attraction

A. A magnet is strongest at its poles.

1. All magnets have two poles- North seeking and South seeking

2. Freely swinging magnets will align themselves with Earth’s poles

3. A lodestone or natural magnet has many poles. North and south poles are equal in number.

B. The law of magnetic attraction states that like poles will repeal and opposite poles will attract.

III. Magnetic Field

A. The magnetic field surrounds a magnet and also has magnetic properties.

1. These fields are present whenever electricity flows.

B. Iron filing sprinkled around a magnet will reveal its field.

1. Lines of force bunch together near the poles.

IV. The Force of Nature and Magnetism

A. Magnets can attract magnetic materials without touching them. A magnetic field can pass through non-magnetic material.

B. Magnetism is attributed to the forces created by electrons spinning around an atom’s nucleus.

1. In nonmagnetic materials, half the atoms spin in one direction and the rest spin in the opposite direction which cancels magnetic effects.

2. In a magnet, most electrons spin in one direction making each atom into a tiny electromagnet.

C. Magnetized atoms cluster together in domains.

1. This arrangement leaves north seeking poles at one end and south seeking poles at the opposite.

2. A bar or rod magnet can be cut in half to create two magnets.

3. Each of the new magnets will also have north and south-seeking poles.

V. The Earth Behaves as a Magnet

A. A suspended magnet will align itself with the Earth’s poles because the Earth itself acts like a large magnet.

1. The north and south magnetic poles are located approximately 1,100 miles from the geographic poles. This variance continues to grow.

B. A compasses needle aligns itself with Earth’s north magnetic pole. When introduced to a magnetic field, a compasses needle will act erratically.

VI. Uses of Magnets and Magnetism

A. Magnets can be used to pick up some metallic objects, to hold metal lids and to attach papers and such to bulletin boards and metal appliances.

B. The brains of many animals contain magnetic material. Scientists think some animals use this to navigate.

C. Magnets are used in electric motors, generators, compasses, toys and games.

D. Maglev or magnetically levitated vehicles use electromagnetism to lift and move passengers and cargo. Maglevs are built either on the attraction or repulsion principle.

1. Electromagnetic Suspension is based on the attraction principle.

2. EDS is based on the repulsion principle.

3. Maglev trains use linear electric motors for propulsion.

VII. Magnets can be Obtained from Electricity

A. Passing an electrical current through a wire will create a magnetic field around the wire.

B. If a live electrical wire is shaped into a coil, that coil will exhibit similar characteristics to a real magnet.

1. A strong electromagnet can be made from a bar of soft iron, an insulated wire and a current source.

2. Magnetism will continue as long as a current is present.

3. Because it demagnetizes rapidly, soft iron is most often used as electromagnetic cores.

4. The poles of an electromagnet can be determined by bringing a compass near it.

5. Poles can be reversed by reversing the current.

6. Commercial electromagnets use one or more core, large amounts of wire and a very strong

electric current.

C. Electromagnets are used in communication, electronics, in motors and many consumer products.

-Static Electricity

I. Static Electricity and How it is Produced

A. Friction produces static electricity.

1. Materials can become electrically charged by rubbing them together.

2. Static electricity is different from current electricity in that static electricity does not move.

II. The Nature of Static Electricity

A. Matter is made of atoms. Atoms are made of electrons, protons and neutrons.

1. Protons and neutrons form the nucleus.

2. Electrons rapidly orbit the nucleus.

3. Electrons move freely within their respective energy levels or shells.

4. Protons carry a positive charge. Electrons a negative charge.

5. Neutrons exhibit no charge at all.

6. Electrically neutral atoms have equal numbers of protons and electrons.

7. Electrons can be transferred by rubbing materials together.

8. The material that losses electrons becomes positively charged and vice versa.

9. Protons cannot be removed by rubbing.

10. Materials will stayed charged as long as the electricity does not leave or enter the material.

B. Static electricity is more easily produced when there is a warm, dry indoor environment coupled with cold outdoor weather.

III. The Law of Electrostatic Attraction and Repulsion

A. Two negatively charged items will repel one another.

B. The same goes for two positively charged objects.

C. Positively and negatively charged material attracts each another.

IV. Why Electrically Charged Materials Attract Materials That Are Not Charged

A. Electrically charged materials will attract those with no charge.

1. Materials not charged are neutral.

2. They have not lost or gained electrons.

B. Negatively charged material will attract the protons in other materials, neutral or charged.

C. Positively charged materials will attract the electrons of other materials.

V. Conductors and Nonconductors

A. Conductors allow an electrical current to easily move through them.

1. These materials have loose electron configurations.

2. Most metals are good conductors.

3. Carbon is a conductor.

4. Ionic compounds are good conductors.

5. Superconductors carry electricity with negligible resistance at room temperatures.

B. Materials that halt the flow of an electric current or charge are insulators or nonconductors.

1. The atoms have a tight hold on their electrons.

2. Paper, wood, glass and rubber are all insulators.

C. Conductors may be supported with nonconductors

1. They are used for insulation.

2. Insulators keep the electricity from straying.

D. Pure water is a nonconductor of electricity. Most water is not pure.

VI. Electric Sparks

A. Air is an insulator.

B. During certain conditions, electricity can flow through the air.

1. The flow may occur when oppositely charged objects are brought near each other.

2. The electrostatic force of attraction is strong.

3. If the force is stronger than the air’s resistance, electricity will discharge.

4. This discharge is seen as a spark flowing through the air.

VII. Lightning and Thunder

A. Lightening is produced during storms.

1. It originates 15,000 to 25,000 feet above sea level.

2. Cloud flashes never touch the ground.

3. There are several types of lightning, including fork, ribbon, ball and bead lightning.

B. Lightning follows the path of least resistance, often striking the tallest most conductive objects.

1. This is why lightning rods are installed in tall buildings.

C. Thunder is caused by lightning rapidly heating and expanding the air.

1. The rumbling sound is caused by echoes created by clouds

2. Lightning is seen before thunder is heard.

3. Light travels faster than sound.

VIII. Other Common Occurrences of Static Electricity

A. Scuffling or walking across a rug and rubbing against fabric can often cause enough friction to make static electricity.

B. Combing your hair with a rubber comb will cause static electricity.

C. Nylon fabrics and undergarments can become charged.

D. Liquid sloshing inside large tanks can also build up a charge.

- Current Electricity

I. Current Electricity

A. Transfer of electrons through a substance is called current electricity.

1. Electrons migrate slowly through a conductor.

2. The force however, moves at 1% the speed of light.

B. In a circuit, electricity flows from the source to the electric object and back to the source.

1. An electric current consists of an energy source, a path and a consumer of the electricity (light bulb).

2. Open circuits are not complete. A completed circuit is also known as a closed circuit.

II. Switches

A. Electricity is often controlled with switches.

B. There are four common switches.

1. Knife

2. Pushbutton

3. Snap

4. Mercury controlled (thermostat)

III. Series and Parallel Circuits

A. Batteries are connected together in a series

1. This increases the electrical force.

B. Appliances that are connected in parallel will all “feel” part of the electricity.

1. Maintains the circuit even when an appliance shuts off

IV. Overloading an Electric Circuit

A. Electricity creates heat.

B. In a house, each circuit is designed to carry limited current.

C. Fuses and circuit breakers are safety devices that open a circuit in the case of an overload.

V. Electrical Units of Measurement

A. Volt –electrical pressure

B. Ampere (Amp) [this is the part that kills you] –electrons per second or current

C. Ohm –unit of electrical resistance

D. Voltage, amperage and ohms are all related.

1. More voltage = more amperage

2. More ohm = less voltage and amperage

E. A watt is a unit of power

VI. Sources of Electricity

A. Electrical energy can be produced, there exists many types

1. Chemical Energy

2. Mechanical Energy

3. Light Energy

4. Heat Energy

B. The wet (voltaic) cell consists of two metals in a chemical solution.

C. In a dry cell the chemicals are sealed within a container.

D. A common storage battery also uses chemical energy.

E. The nickel-cadmium (nicad) is small, efficient and performs like a storage battery.

F. The fuel cell uses gasses like hydrogen to create energy

G. Generators operate on the mechanical principle.

H. Electricity produced at power plants consists of high voltage

I. Alternating current alternates many times per second.

J. Direct current is used to charge batteries and plate metal objects

K. The piezoelectric cell uses mechanical energy.

L. The photoelectric cell uses light energy

M. The thermocouple uses heat energy

VII. Uses of Electricity

A. To produce heat

B. To produce light

C. To produce motion and power electrical motors

D. Electric motors can be turned into generators and visa versa

E. To plate metals

F. Electricity is also used in communication